PATENTS · DESIGNS · COPYRIGHT · TRADE MARKS
The Patent Office

10/509907

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN
COMPLIANCE WITH
RULE 17.1(a) OR (b)

REC'D 08 MAY 2003
WIPO PCT

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

I also certify that by virtue of an assignment registered under the Patents Act 1977, the application is now proceeding in the name as substituted.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

BEST AVAILABLE COPY

Signed

Dated 29 April 2003

PATENTS • DESIGNS • COPYRIGHT • TRADE MARKS
The Patent Office
INVESTOR IN PEOPLE

GB 0216258.4

By virtue of a direction given under Section 30 of the Patents Act 1977, the application is proceeding in the name of

SHANE ENGINES LIMITED,
Hatchgate Farm,
Plough Lane,
Bramshill,
Nr Hook,
Hampshire,
RG27 0JX,
United Kingdom

Incorporated in the United Kingdom,

[ADP No. 08465304001]

Patents Form 1/77

Patents Act 1977
(Rule 16)

THE PATENT OFFICE
A
12 JUL 2002
LONDON

PATENTS • DESIGNS • COPYRIGHT • TRADE MARKS
The Patent Office

15JUL02 E733110-3 D00001
P01/7700 0.00-0216258.4

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference — GCL/8730

2. Patent application number *(The Patent Office will fill in this part)* — 0216258.4

12 JUL 2002

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

HUMPHRIES, Robin
Hatchgate Farm
Plough Lane
Bramshill Nr Hook
Hampshire RG27 0JX

SECTION 15(4) 1977 ACT APPLICATION FILED 12 JUL 2002 16/9/02

Patents ADP number *(if you know it)* 8354870001

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention — A mechanism including a piston-and-cylinder assembly

5. Name of your agent *(if you have one)* — Abel & Imray

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

20 Red Lion Street
London
WC1R 4PQ
United Kingdom

Patents ADP number *(if you know it)* 174001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
United Kingdom (GB)	0207390.6	28 March 2002

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

No

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	13 ✓ CF
Claim(s)	7 ✓
Abstract	0
Drawing(s)	6 + 6

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	— —
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Abel & Imray Date

Abel & Imray 12 July 2002

12. Name and daytime telephone number of person to contact in the United Kingdom Mr G Leila 0207 242 9984

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.

b) Write your answers in capital letters using black ink or you may type them.

c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.

d) If you have answered 'Yes' Patents Form 7/77 will need to be filed.

e) Once you have filled in the form you must remember to sign and date it.

f) For details of the fee and ways to pay please contact the Patent Office.

DUPLICATE

A mechanism including a piston-and-cylinder assembly

The invention relates to a mechanism including a piston-and-cylinder assembly.

The invention provides a mechanism including:

a piston-and-cylinder assembly including a piston housed in a cylinder,

a pin member passing through the piston and

a guide member having a guide slot accommodating an end of the pin member,

the guide slot being so shaped and orientated in relation to the piston-and-cylinder assembly that a common axis exists between the guide slot and the piston-and-cylinder assembly,

the guide member and the piston-and-cylinder assembly being so mounted as to be rotatable relative to each other about the common axis and

the guide slot being so shaped as to guide the pin member in a continuous curve, causing the piston to sweep up and down the cylinder, when the guide member and the piston-and-cylinder assembly rotate relative to each other.

Preferably, the mechanism includes axial slots in the cylinder, the pin member engaging the axial slots and, preferably, the axial slots lie on a diameter of the cylinder.

An aspect of the invention is the provision of a mechanism including:

a piston-and-cylinder assembly including a first piston housed in a first cylinder and a second piston housed in a second cylinder,

a first pin member passing through the first piston and a second pin member passing through the second piston and

a guide member having a guide slot accommodating an end of the first pin member and an end of the second pin member,

the guide slot being so shaped and orientated in relation to the piston-and-cylinder assembly that a common axis exists between the guide slot and the piston-and-cylinder assembly,

~~the guide member and the piston-and-cylinder assembly~~ being so mounted as to be rotatable relative to each other about the common axis and

the guide slot being so shaped as to guide the pin members in a continuous curve, causing the first and second piston to sweep up and down the cylinder, when the guide member and the piston-and-cylinder assembly rotate relative to each other.

Preferably, the form of the piston-and-cylinder assembly permits the first and second cylinders to lie diametrically opposed to each other.

Preferably, the mechanism includes at least one further pair of diametrically opposed cylinders on the piston-and-cylinder assembly,

further pistons in the further cylinders and

further pin members passing through the pistons and being accommodated in the guide slot.

Preferably, the guide slot is of a rhomboid shape with curved corners and, preferably, the curved corners are parts of ellipses.

Alternatively, the guide slot is elliptical in shape.

As another alternative, the guide slot includes three parts which are elliptical in shape and a fourth part which is substantially straight, the straight part occupying a position corresponding to the expansion stroke of the piston or pistons.

As yet another alternative, the guide slot has a dumbell shape including curved end portions separated by a narrower waist portion.

Preferably, the mechanism includes a second guide member having a second guide slot accommodating the other end of the pin member or the other ends of the pin members, the second guide slot being so shaped and orientated in relation to the piston-and-cylinder assembly as to share the common axis existing between the first guide slot and the piston-and-cylinder assembly

Preferably, the mechanism includes axial slots in the cylinders, the pin members engaging the axial slots and, preferably, the axial slots lie on diameters of the cylinders.

In one arrangement, the common axis is the axis of a shaft on which the piston-and-cylinder assembly is rotatably mounted, the remainder of the mechanism being fixed.

In another arrangement, the common axis is the axis of a shaft on which the guide member is rotatably mounted or the guide members are rotatably mounted, the piston-and-cylinder assembly being fixed.

In a further arrangement, the guide member is or the guide members are rotatably mounted on the shaft and so is the piston-and-cylinder assembly.

Preferably, the mechanism includes bearing means at the end of the pin member or the ends of pin members accommodated in a guide slot, for effecting rolling contact between the peripheries of the guide slot and the end of the pin member or the ends of the pin members.

Preferably, the bearing means at the end of the pin member or the ends of the pin members includes an outer bearing assembly contacting only the outer periphery of a

guide slot and an inner bearing assembly contacting only the inner periphery of the guide slot.

Preferably, the outer bearing assembly includes an outer cylindrical shell supported by a plurality of outer rollers on the pin member, the outer cylindrical shell lying in contact with the outer periphery only of the guide slot.

Preferably, the inner bearing assembly includes an inner cylindrical shell supported by a plurality of inner rollers on the pin member, the inner cylindrical shell lying in contact with the inner periphery only of the guide slot.

In one arrangement, the outer and inner bearing assemblies are so mounted that the outer and inner cylindrical shells rotate about the same axis.

In one arrangement, the outer and inner bearing assemblies are so mounted that the outer and inner cylindrical shells rotate about the axis of the pin member.

In an alternative arrangement, the outer and inner bearing assemblies are so mounted that the outer cylindrical shell rotates about an axis which is offset from the axis about which the inner cylindrical shell rotates.

In one arrangement, the bearing means includes a ball bearing between the outer and inner bearing assemblies, the balls of the ball bearing running in tracks in the outer and inner cylindrical shells.

Preferably, the mechanism includes a guide slot having an inner periphery including a step in its profile for accommodating bearing means at the end of the pin member or the ends of the pin members, the bearing means including an outer bearing assembly contacting only the outer periphery

of a guide slot and an inner bearing assembly contacting only the inner periphery of the guide slot.

Preferably, the mechanism includes a guide slot having an outer periphery which is narrower than the inner periphery, bearing means at the end of the pin member or the ends of the pin members including an outer bearing assembly contacting only the narrower outer periphery of a guide slot and an inner bearing assembly contacting only the inner periphery of the guide slot.

Preferably, a plurality of apertures are included in the pin member or pin members for receiving and distributing lubricant to the end of the pin member or pin members.

Preferably, the mechanism includes a guide member having at least one aperture so positioned as to permit the delivery of lubricant through the guide member to the pin member or pin members.

A mechanism in accordance with the invention may be included in a heat engine, wherein the pistons and cylinders are pistons and cylinders of the heat engine and, in operation, generate motive power for the mechanism.

Preferably, the heat engine is an internal combustion engine.

The heat engine may be a Diesel-cycle engine or, alternatively, an Otto-cycle engine.

A mechanism in accordance with the invention will now be described by way of example only with reference to the accompanying drawings in which:

Fig. 1 represents a front view of the mechanism showing a guide slot of a first guide member accommodating six pin members and a piston-and-cylinder assembly having six cylinders rotatably mounted on a shaft,

Fig. 2 represents a front view of a second guide member having a guide slot accommodating four pin members,

Fig. 3 represents a front view of a piston-and-cylinder assembly showing details of a cylinder of a four-cylinder arrangement,

Fig. 4 represents a side view of the piston-and-cylinder assembly of Fig. 3,

Fig. 5 represents a cross-section through the axis of a pin member and a guide member showing bearing means between the pin member and the guide member,

Fig. 6 represents and end view of the pin member supported by a plurality of rollers forming part of the bearing means of Fig. 5,

Fig. 7 represents a front view of a third guide member having a shape of guide slot differing in shape from the first and second guide slots,

Fig. 8 represents a cross-section of the guide member of Fig.7 taken along the line AA,

Fig. 9 represents a cross-section of the guide member of Fig.7 taken along the line BB,

Fig. 10 represents a perspective view of the guide member of Fig. 7 and

Fig. 11 represents another perspective view of the guide member of Fig. 7.

Referring to Fig. 1 of the accompanying drawings, the mechanism includes a piston-and-cylinder assembly including a disc-shaped carrier member 1 on which are mounted six cylinders 2 to 7 housing six pistons 8 to 13. Six pin members 14 to 19 pass diametrically through the pistons 8 to 13 and one set of the ends of the pin members 14 to 19 are accommodated in a guide slot having peripheries 20, 21 in a guide member (not shown). The piston-and-cylinder assembly and the guide slot have a common axis 22. The

piston-and-cylinder assembly is mounted on a shaft 23 the axis of which is the common axis 22. The piston-and-cylinder assembly is attached to the shaft 23 and is rotatable about the common axis 22.

Although not shown in Fig. 1, the mechanism includes a second guide slot in a second guide member for accommodating the other set of the ends of the pin members 14 to 19, the guide slots being of the same shape.

The six cylinders 2 to 7 are evenly spaced around the disc-shaped carrier member 1, their axes being 60 degrees apart. The peripheries 20, 21 of the guide slot are of a rhomboid shape with curved corners resulting in a guide slot which is of a rhomboid shape with curved corners. The curved corners of the guide slot are parts of ellipses and the guide slot is relatively straight between the curved corners.

In the operation of the mechanism shown in Fig. 1, the piston-and-cylinder assembly rotates about the common axis 22 and the pin members 14 to 19 move along the guide slot, the pistons 8 to 13 sweeping up and down the cylinders 2 to 7 as the pin members 14 to 19 move along the guide slot.

The mechanism shown in Fig. 1 forms a part of a heat engine in which the pistons and cylinders are pistons and cylinders of the heat engine and, in operation, generate motive power for the mechanism.

The details of the heat engine are not shown in Fig. 1

The energy generated in the cylinders 2 to 7 and pistons 8 to 13 as cylinders and pistons of the heat engine, causing the pistons 8 to 13 to reciprocate in the cylinders 2 to 7, is translated into rotary motion of the piston-and-rotor assembly a s a result of the pin members 14 to 19 moving along the guide slot shown in Fig. 1 and the second guide slot which is not shown. Poppet valves are

included in the heads of the cylinders 2 to 7 and are controlled by static cams which are adjustable in order to vary the lift and dwell, thereby altering the performance of the heat engine. Co-operating cams are housed in a static part of the heat engine housing and a valve lifting mechanism may be included in the event that it is deemed necessary. In the case of a Diesel-cycle heat engine, an additional cam is added in order to operate an injection pump on the cylinder head or electrically operated injectors may be provided.

The operating gas for the heat engine enters by way of the centre of the shaft 23 and is transferred to the heads of the cylinders 2 to 7 by way of radial ports. The gas charges are compressed in the ports as a result of acceleration due to the rotary motion of the piston-and-cylinder assembly, giving an added benefit of pre-compression and added density within the combustion chamber controlled by the inlet valve.

An exhaust port is controlled by an exhaust valve and exhaust gases leave the heat engine by way of a radial gallery on the side of the heat engine. Engine lubrication is effected by a pressurised oil system and cooling is effected by a radiator. Rotation is counter-clockwise as viewed in Fig. 1.

The arrangement shown in Fig. 1 is ideal as regards balance since the opposed-piston configuration provides good counterbalance. For good balance, a minimum of two cylinders is required.

Variation of the shapes of the guide slots may be used in order to vary the performance of the mechanism and a heat engine including the mechanism. Variation of the size and, consequently, the weight of the piston-and-cylinder assembly provides for different power characteristics.

There are four parts to the guide slot corresponding to the induction, compression, expansion and exhaust strokes of the operating cycle of a reciprocating heat engine and, consequently, there is ignition once per revolution. That contrasts with more conventional four-stroke arrangements in which there is ignition once every two revolutions, thus a heat engine including the mechanism produces twice as many ignition strokes as a conventional four-stroke arrangement, leading improved power output at lower revolutions.

Referring to Fig. 2 of the accompanying drawings, a guide member 30 having a guide slot with peripheries 31, 32 accommodating four pin members 33 to 36 has a common axis 37 with a corresponding piston-and-cylinder assembly which is not shown. The corresponding piston-and-cylinder assembly has four pistons and cylinders spaced ninety degrees apart for ideal balance conditions. The operation of the mechanism of Fig. 2 is the same as the operation of the mechanism of Fig. 1 described above and the operation of a heat engine including the mechanism of Fig. 2 is the same as the operation of a heat engine as described above with reference to Fig. 1, except that a four-cylinder heat engine is expected to generate less power than a six-cylinder engine.

The guide slot shown in Fig. 2 has a rhomboid form with curved corners which are parts of ellipses. The guide slot has, in effect, four parts and those parts correspond to the four strokes of a four-stroke heat engine which provide the induction, compression, expansion and exhaust phases of operation. There are alternative shapes for the guide slot. For example, the guide slot may be elliptical in shape or may include three parts which are elliptical and a fourth part which is substantially straight, the

fourt part corresponding to the expansion phase of operation.

Referring to Fig. 3 of the accompanying drawings, a piston-and-cylinder assembly includes four cylinders spaced ninety degrees apart and one cylinder 40 includes an axial slot 42 through which a pin member 41 passes, the pin member 41 also passing through the piston which is not visible. The axial slot 42 lies on a diameter of the cylinder 40 and facilitates the assembly of the mechanism by holding the piston in the cylinder in the absence of a guide slot for performing that function. The slot 42 is longer than the stroke of the piston as set by the guide slot and, consequently, the slot 42 does not influence the operation of the mechanism.

Referring to Fig. 4 of the accompanying drawings, the pin member 41 of Fig. 3 protrudes both forward and backwards for engagement with front and rear guide slots (not shown) as does a further pin member 51. Valve members 52 and 53 are also shown in Fig. 4.

The pistons of the arrangements described above may be stepped in diameter, having the smaller or smallest diameter at the position at which the pin member is accommodated.

Referring to Fig. 5 of the accompanying drawings, a pin member such as the pin member 14, say, of Fig. 1 has bearing means including an outer bearing assembly and an inner bearing assembly. The outer bearing assembly includes an outer cylindrical shell 142 and a plurality of cylindrical rollers 1421 supporting the outer cylindrical shell 142 on the pin member 14. The inner bearing assembly includes an inner cylindrical shell 141 and a plurality of cylindrical rollers 1411 supporting the inner cylindrical shell 141 on the pin member 14. The inner cylindrical shell

141 includes a peripheral protrusion and the outer cylindrical shell 142 includes a peripheral depression into which the peripheral protrusion of the inner cylindrical shell 142 fits. The outer and inner bearing assemblies 142 and 141 are retained on the pin member 14 by a retaining clip 155 and the fact that the end diameter of the pin member is reduced in relation to the body of the pin member 14.

The outer periphery 31 of the guide slot in a guide member 300 is narrower than the inner periphery 32a, 32b of the guide slot in the guide member 300 and the inner periphery has two surfaces 32a and 32b between which there is a step. The step in the inner periphery of the guide slot in the guide member 300 permits the outer cylindrical shell 142 to run clear of surface 32a of the inner periphery while in contact with the outer periphery 310 of the guide slot. The inner cylindrical shell 141 runs along the surface 32b of the inner periphery of the guide slot and runs clear of the outer periphery 310 which does not extend up to the inner cylindrical shell 141. The arrangement shown in Fig. 5 permits the pin member 14 to be guided along the guide slot in contact with the inner and outer peripheries of the guide slot, the inner and outer cylindrical shells rotating in opposite senses.

A ball bearing may be introduced at the interface between the inner and outer cylindrical shells 141 and 142 by providing tracks in the inner and outer cylindrical shells 141 and 142 where they interface and placing a plurality of balls in the tracks.

As shown in Fig. 5, the pin member 14 is a cylindrical tube and includes a first plurality of axial apertures 143 - 148 in the vicinity of the bearing means at the end of the pin member 14 giving access to the interior of the pin

member 14. A second plurality of axial apertures 149 - 154 is provided at the opposite end of the pin member 14 giving access to the interior of the pin member 14. The axial apertures serve to distribute lubricant to the bearing means at the ends of the pin member 14, the lubricant being injected into the interior of the pin member 14 through apertures in the guide member 300.

Referring to Fig. 6 of the accompanying drawings, an end view of the pin member 14 at the bearing means shows that there are sixteen rollers 1421 included in the outer bearing assembly.

Referring to Fig. 7 of the accompanying drawings, the guide member 300 includes a guide slot which is symmetrical about the line AA and, also, about the line BB. The guide slot is dumbbell-shaped, including rounded end portions and narrowing between the rounded end portions. Fig. 7 shows four apertures 301 - 304 in the guide member 300. Lubricant injected through the apertures 301- 304 enters a pin member as it passes the apertures 301 - 304 and is delivered to the bearing means on the pin member through the axial apertures 143 - 154 shown in Fig. 5.

Referring to Figs. 8 and 9 of the accompanying drawings, the apertures 301 - 304 for lubricant are shown as is the narrower outer periphery 310 of the guide slot compared with the total width of the surfaces 32a and 32b making up the inner periphery of the guide slot.

Referring to Figs. 10 and 11 of the accompanying drawings, perspective views of the guide member 300 show the apertures 301 - 304, the outer periphery 310 of the guide slot and the surfaces 32a and 32b making up the inner periphery of the guide slot.

Referring again to Fig. 5, as an alternative to the arrangement shown in which the outer and inner bearing

assemblies 141, 1411, 142, 1421 are so mounted as to rotate about the axis of the pin member 14, the outer bearing assembly 142, 1421 may be so mounted in relation to the mounting of the inner bearing assembly 141, 1411 that the outer cylindrical shell 1421 rotates about an axis which is offset from the axis about which the inner cylindrical shell 141 rotates. An offset in the axes of rotation serves to hold the outer and inner bearing assemblies 141, 1411, 142, 1421 more positively in contact with the surfaces 310 and 32b.

A basic mechanism in accordance with the invention requires one piston and one cylinder with a pin member in engagement with one guide slot and, as is indicated in relation to Fig. 3, an axial slot in the cylinder is not essential to the operation of the mechanism although a slot in the cylinder facilitates assembly.

The basic mechanism is operable as a part of a heat engine, but if driven, is operable as a pump. Diesel-cycle and Otto-cycle heat engines are suitable and steam engines are also suitable.

Further, either the piston-and-cylinder assembly or the guide member providing the guide slot may be rotatable or both may be rotatable to provide counter-rotating output shafts.

As is made clear above, balanced arrangements based on evenly spaced opposed cylinders are preferred and rotation of the piston-and-cylinder assembly is preferred.

The axial slots in the cylinders could lie on a chord of the cylinder instead of a diameter of the cylinder but the position on the diameter leads to better balance.

CLAIMS

1. A mechanism including:

a piston-and-cylinder assembly including a piston housed in a cylinder,

a pin member passing through the piston and

~~a guide member having a guide slot accommodating an~~ end of the pin member,

the guide slot being so shaped and orientated in relation to the piston-and-cylinder assembly that a common axis exists between the guide slot and the piston-and-cylinder assembly,

the guide member and the piston-and-cylinder assembly being so mounted as to be rotatable relative to each other about the common axis and

the guide slot being so shaped as to guide the pin member in a continuous curve, causing the piston to sweep up and down the cylinder, when the guide member and the piston-and-cylinder assembly rotate relative to each other.

2. A mechanism as claimed in claim 1, including axial slots in the cylinder, the pin member engaging the axial slots.

3. A mechanism as claimed in claim 2, wherein the axial slots lie on a diameter of the cylinder.

4. A mechanism including:

a piston-and-cylinder assembly including a first piston housed in a first cylinder and a second piston housed in a second cylinder,

a first pin member passing through the first piston and a second pin member passing through the second piston and

a guide member having a guide slot accommodating an end of the first pin member and an end of the second pin member,

the guide slot being so shaped and orientated in relation to the piston-and-cylinder assembly that a common axis exists between the guide slot and the piston-and-cylinder assembly,

the guide member and the piston-and-cylinder assembly being so mounted as to be rotatable relative to each other about the common axis and

the guide slot being so shaped as to guide the pin members in a continuous curve, causing the first and second piston to sweep up and down the cylinder, when the guide member and the piston-and-cylinder assembly rotate relative to each other.

5. A mechanism as claimed in claim 4, wherein the form of the piston-and-cylinder assembly permits the first and second cylinders to lie diametrically opposed to each other.

6. A mechanism as claimed in claim 5, including at least one further pair of diametrically opposed cylinders on the piston-and-cylinder assembly,

further pistons in the further cylinders and

further pin members passing through the pistons and being accommodated in the guide slot.

7 A mechanism as claimed in any one of claims 1 to 6, wherein the guide slot is of a rhomboid shape with curved corners.

8. A mechanism as claimed in claim 7, wherein the curved corners are parts of ellipses.

~~9. A mechanism as claimed in any one of claims 1 to 6,~~ wherein the guide slot is elliptical in shape.

10. A mechanism as claimed in any one of claims 1 to 6, wherein the guide slot includes three parts which are elliptical in shape and a fourth part which is substantially straight, the straight part occupying a position corresponding to the expansion stroke of the piston or pistons.

11. A mechanism as claimed in any one of claims 1 to 6, wherein the guide slot has a dumbell shape including curved end portions separated by a narrower waist portion.

12. A mechanism as claimed in any one of claims 1 to 11, including a second guide member having a second guide slot accommodating the other end of the pin member or the other ends of the pin members, the second guide slot being so shaped and orientated in relation to the piston-and-cylinder assembly as to share the common axis existing between the first guide slot and the piston-and-cylinder assembly

13. A mechanism as claimed in any one of claims 4 to 6 and claims 7 to 12 when appended to any one of claims 4 to 6,

including axial slots in the cylinders, the pin members engaging the axial slots.

14. A mechanism as claimed in claim 13, wherein the axial slots lie on diameters of the cylinders.

15. A mechanism as claimed in any one of claims 1 to 14, wherein common axis is the axis of a shaft on which the piston-and-cylinder assembly is rotatably mounted, the remainder of the mechanism being fixed.

16. A mechanism as claimed in any one of claims 1 to 14, wherein the common axis is the axis of a shaft on which the guide member is rotatably mounted or the guide members are rotatably mounted, the piston-and-cylinder assembly being fixed.

17. A mechanism as claimed in any one of claims 1 to 14, wherein the common axis is the axis of a shaft on which the guide member is or the guide members are rotatably mounted and the piston-and-cylinder assembly is rotatably mounted on the shaft.

18. A mechanism as claimed in any one of claims 1 to 17, including bearing means at the end of the pin member or the ends of pin members accommodated in a guide slot, for effecting rolling contact between the peripheries of the guide slot and the end of the pin member or the ends of the pin members.

19. A mechanism as claimed in claim 18, wherein the bearing means at the end of the pin member or the ends of the pin members includes an outer bearing assembly

contacting only the outer periphery of a guide slot and an inner bearing assembly contacting only the inner periphery of the guide slot.

20. A mechanism as claimed in claim 19, wherein the outer bearing assembly includes an outer cylindrical shell supported by a plurality of outer rollers on the pin member, the outer cylindrical shell lying in contact with the outer periphery only of the guide slot.

21. A mechanism as claimed in claim 19 or claim 20, wherein the inner bearing assembly includes an inner cylindrical shell supported by a plurality of inner rollers on the pin member, the inner cylindrical shell lying in contact with the inner periphery only of the guide slot.

22. A mechanism as claimed in claim 20 or claim 21, wherein the outer and inner bearing assemblies are so mounted that the outer and inner cylindrical shells rotate about the same axis.

23. A mechanism as claimed in any one of claims 20 to 22, wherein the outer and inner bearing assemblies are so mounted that the outer and inner cylindrical shells rotate about the axis of the pin member.

24. A mechanism as claimed in claim 20 or claim 21, wherein the outer and inner bearing assemblies are so mounted that the outer cylindrical shell rotates about an axis which is offset from the axis about which the inner cylindrical shell rotates.

25. A mechanism as claimed in any one of claims 20 to 23, wherein the bearing means includes a ball bearing between the outer and inner bearing assemblies, the balls of the ball bearing running in tracks in the outer and inner cylindrical shells.

26. A mechanism as claimed in any one of claims 1 to 25, including a guide slot having an inner periphery including a step in its profile for accommodating bearing means at the end of the pin member or the ends of the pin members, the bearing means including an outer bearing assembly contacting only the outer periphery of a guide slot and an inner bearing assembly contacting only the inner periphery of the guide slot.

27. A mechanism as claimed in any one of claims 1 to 26, including a guide slot having an outer periphery which is narrower than the inner periphery, bearing means at the end of the pin member or the ends of the pin members including an outer bearing assembly contacting only the narrower outer periphery of a guide slot and an inner bearing assembly contacting only the inner periphery of the guide slot.

28. A mechanism as claimed in any one of claims 1 to 27, wherein a plurality of apertures are included in the pin member or pin members for receiving and distributing lubricant to the end of the pin member or pin members.

29. A mechanism as claimed in claim 28, including a guide member having at least one aperture so positioned as to permit the delivery of lubricant through the guide member to the pin member or pin members.

30. A mechanism substantially as herein described with reference to and as shown in the accompanying drawings.

31. A heat engine including a mechanism as claimed in any one of claims 1 to 30, wherein the pistons and cylinders are pistons and cylinders of the heat engine and, in operation, generate motive power for the mechanism.

32. A heat engine as claimed in claim 31, which is an internal combustion engine.

33. An engine as claimed in claim 32, which is a Diesel-cycle engine.

34. An engine as claimed in claim 32, which is an Otto-cycle engine.

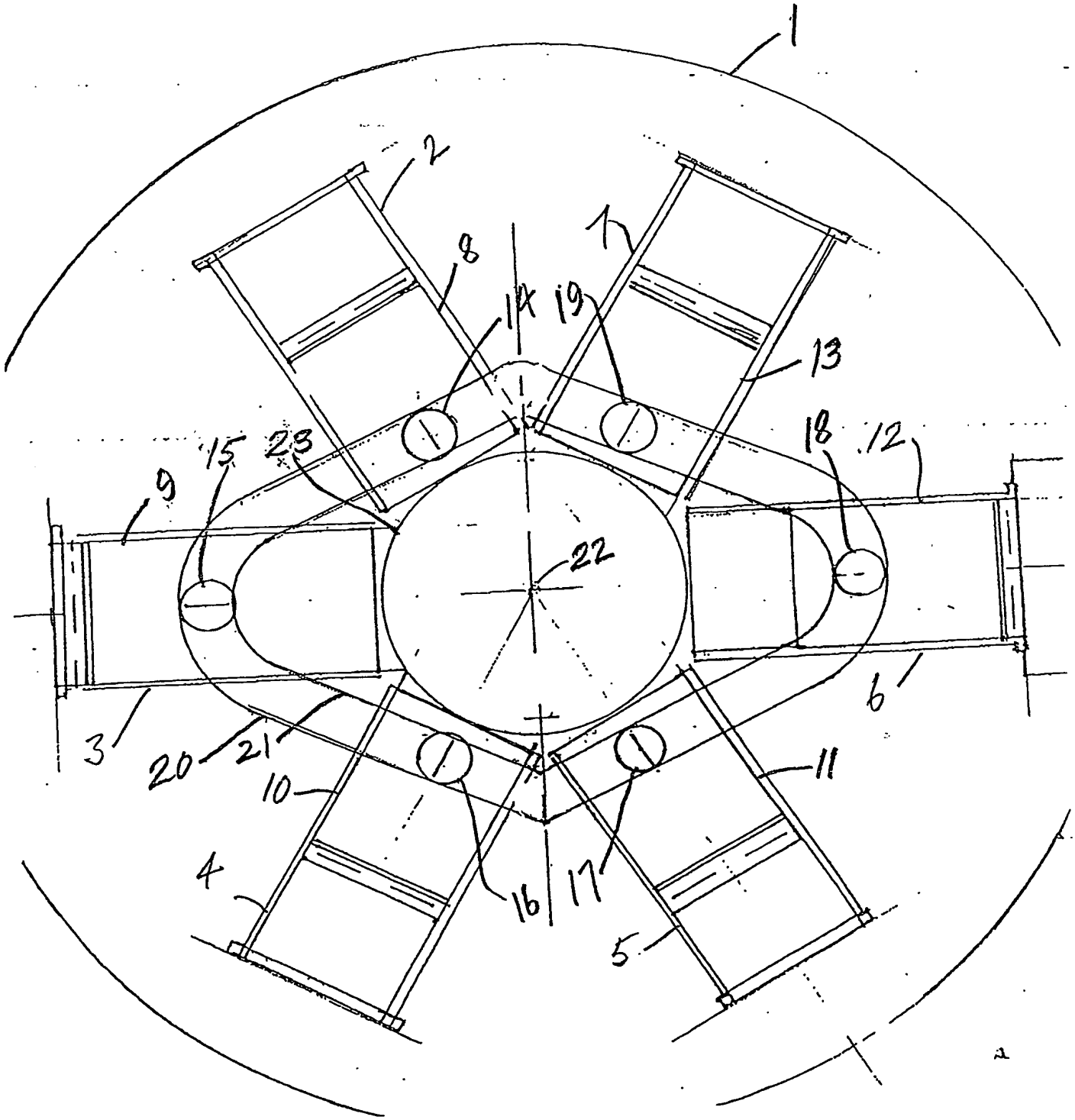

Fig 1

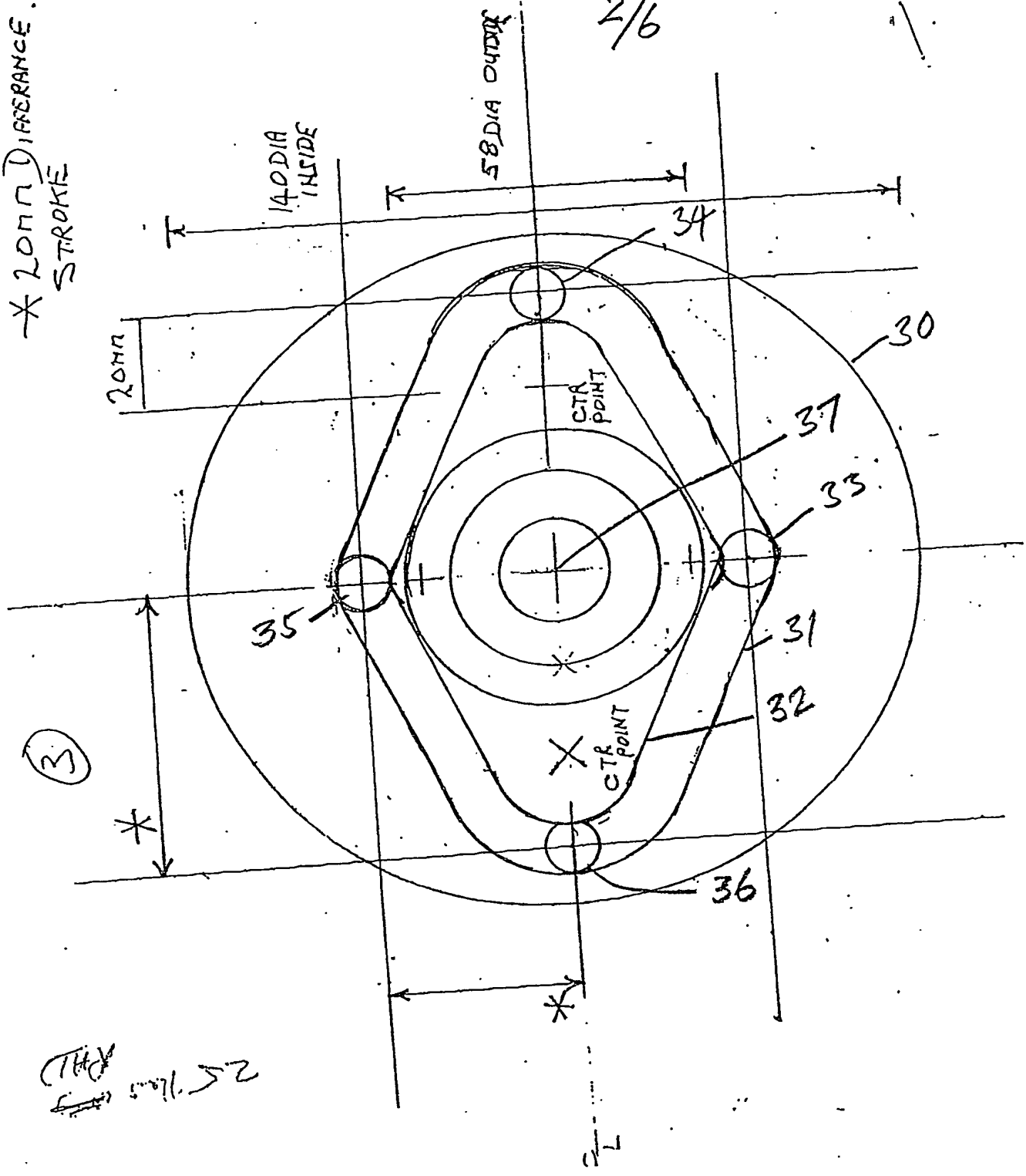
* 20mm DIMENSION. STROKE
140 DIA INSIDE
58 DIA OUTSIDE
20mm
CTR POINT
CTR POINT
34
30
37
33
35
31
32
36
3

Fig 2

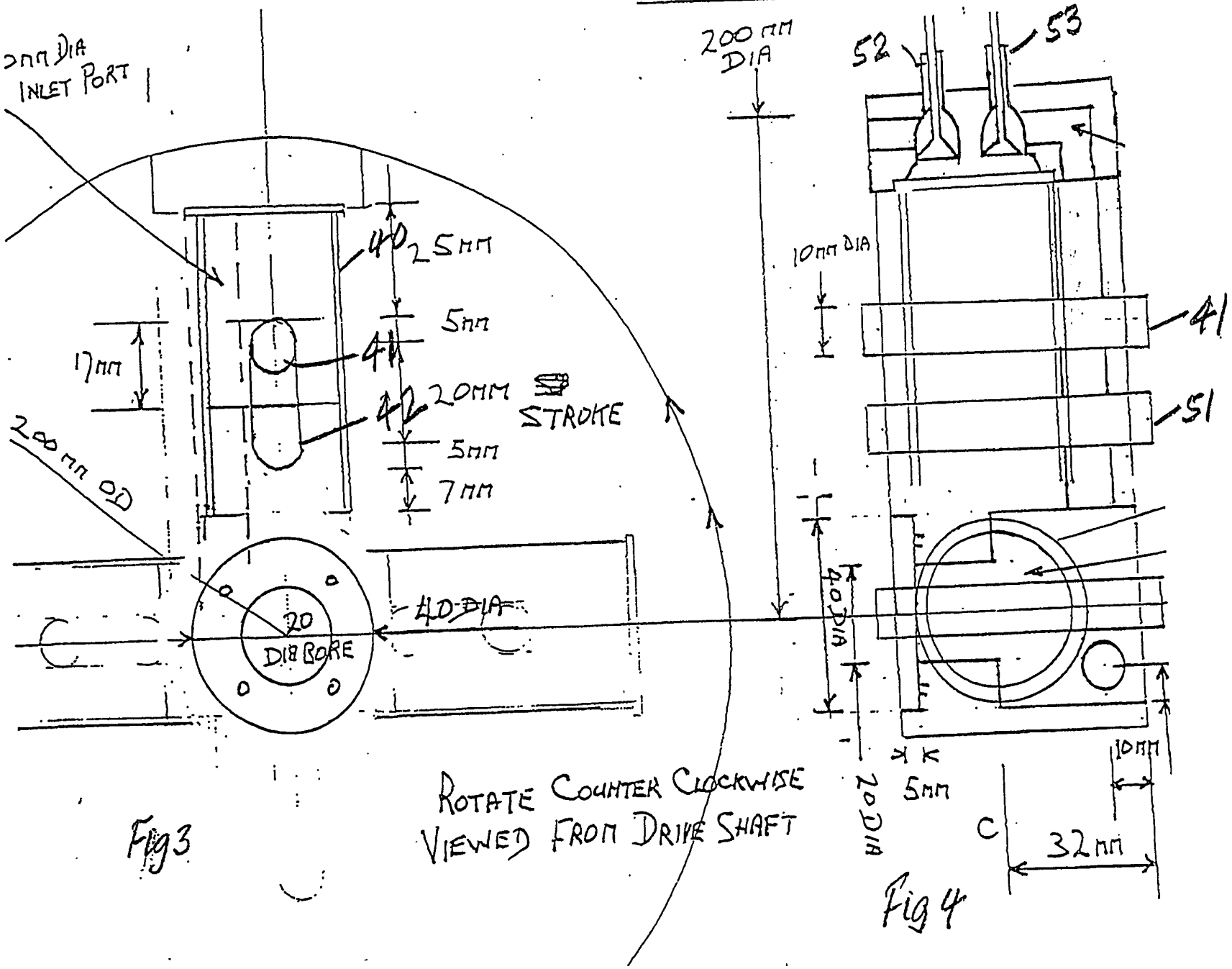

Fig 3

ROTATE COUNTER CLOCKWISE
VIEWED FROM DRIVE SHAFT

Fig 4

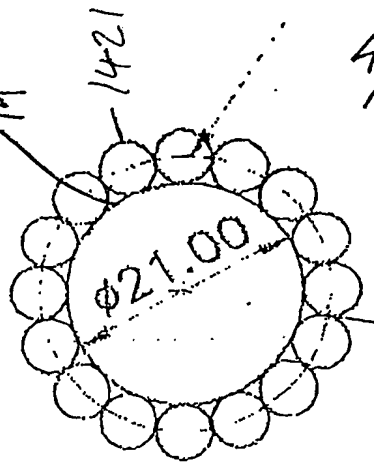
14
1421
Φ21.00

Fig 6

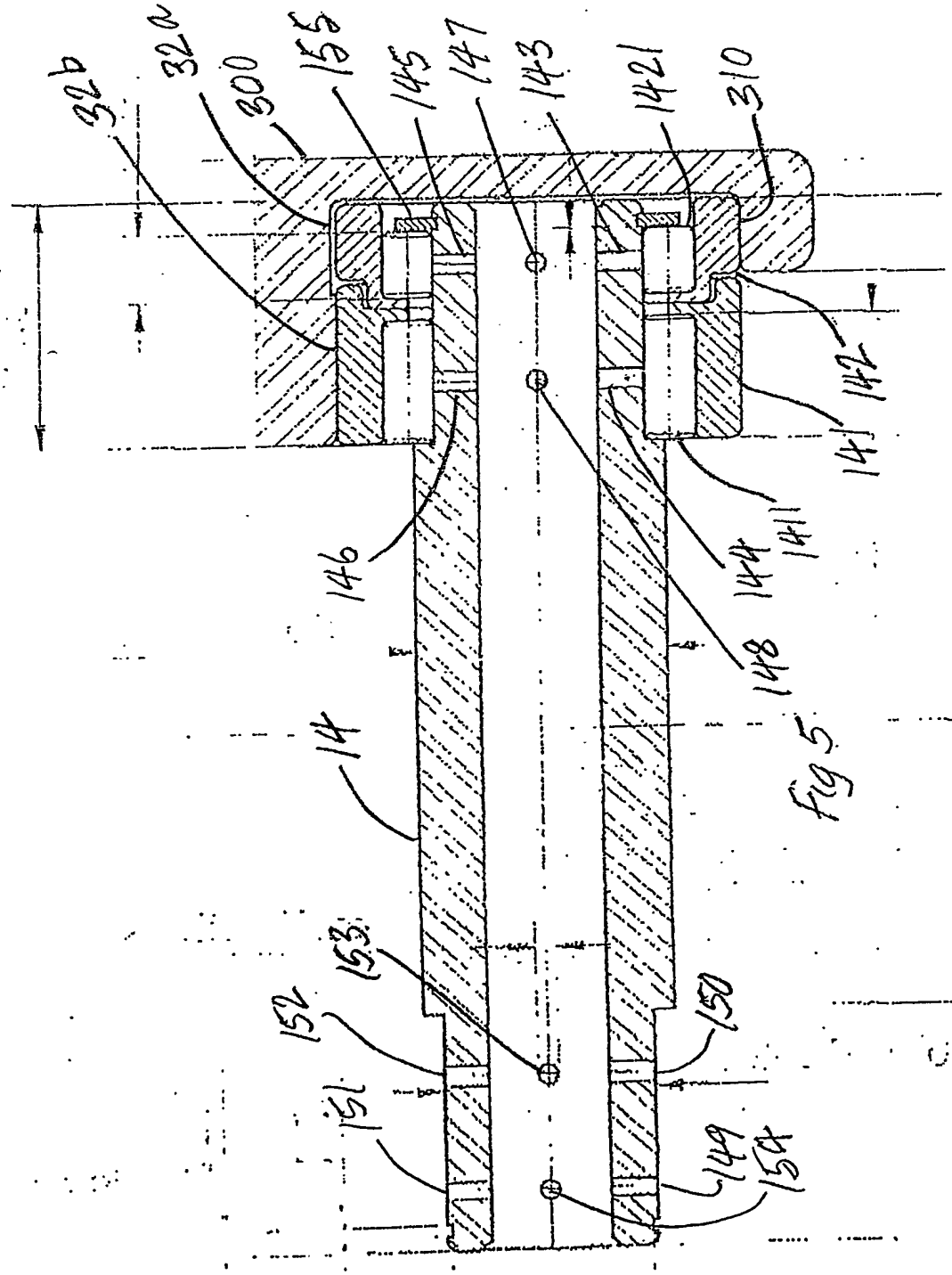
324
320
300
155
145
147
143
1421
310
142
141
144
148
146
14
153
152
151
150
149
154

Fig 5

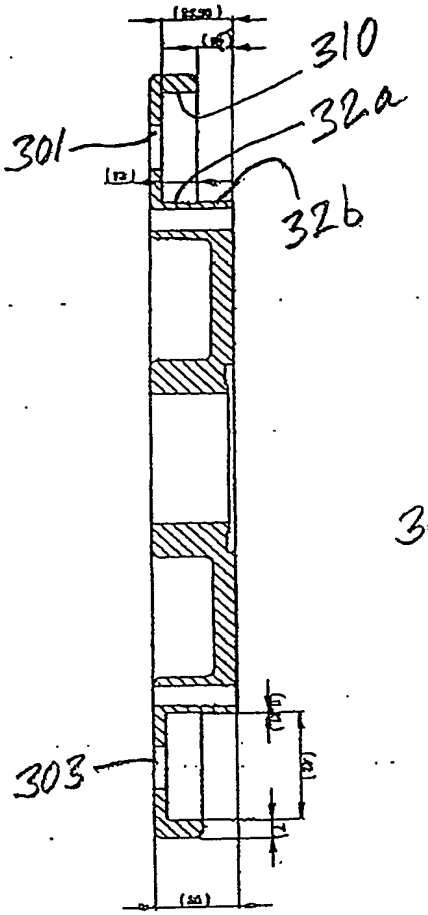

Fig 8

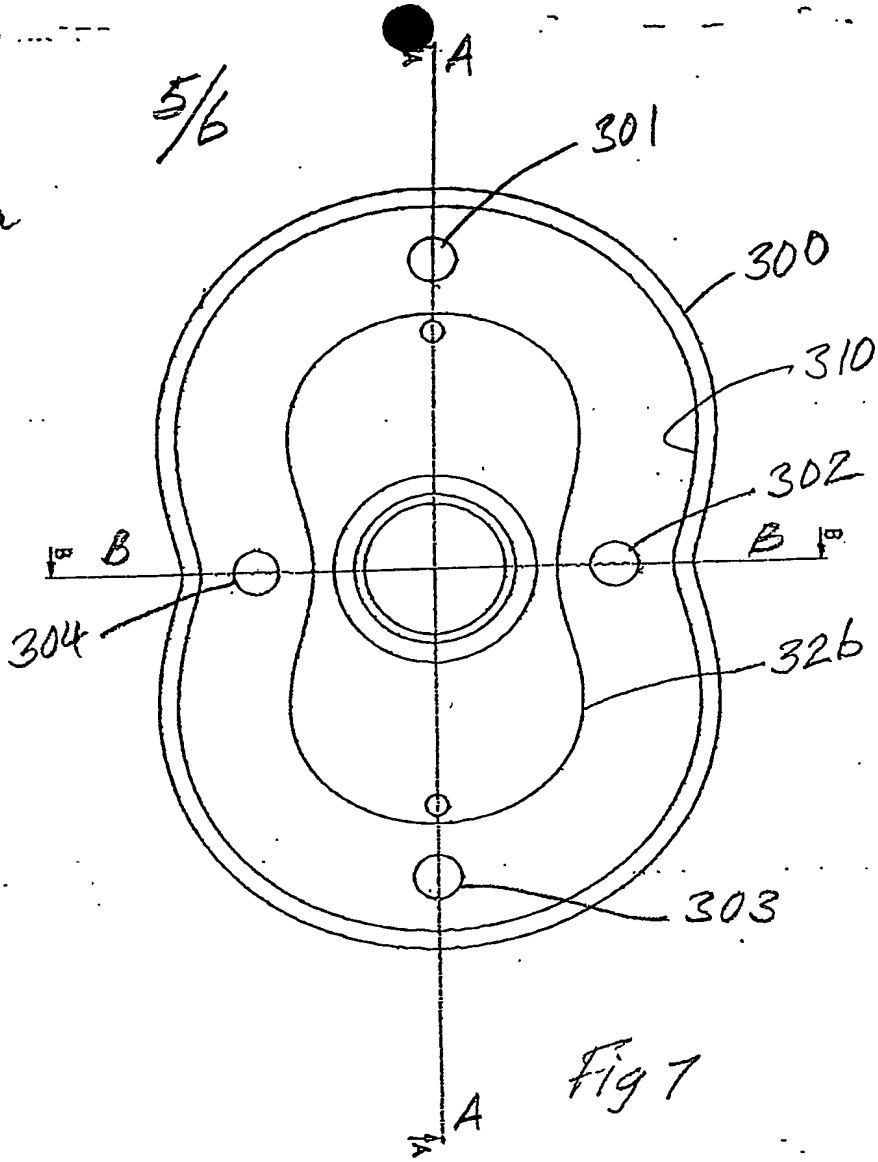

Fig 7

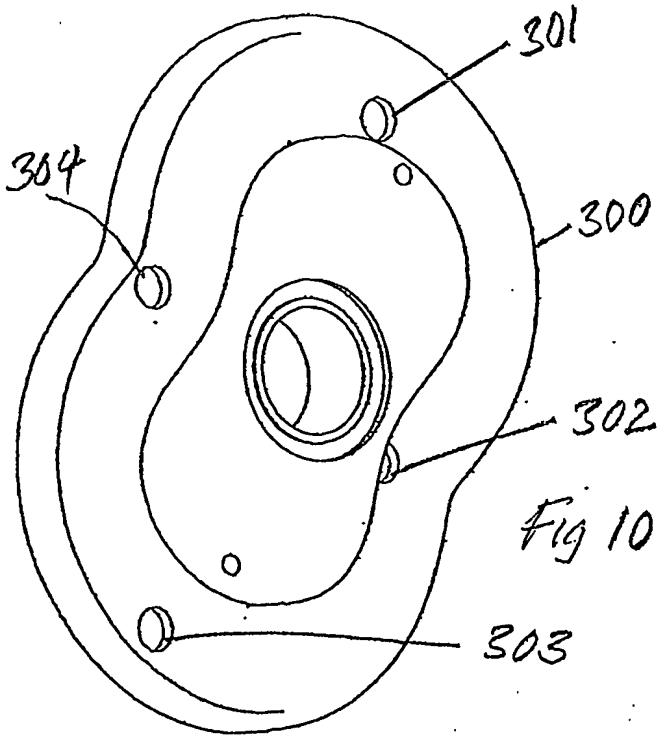

Fig 10

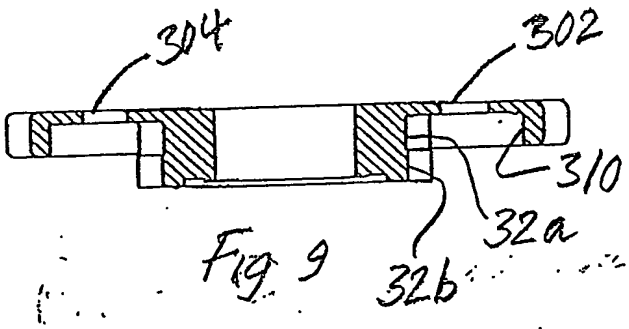

Fig 9

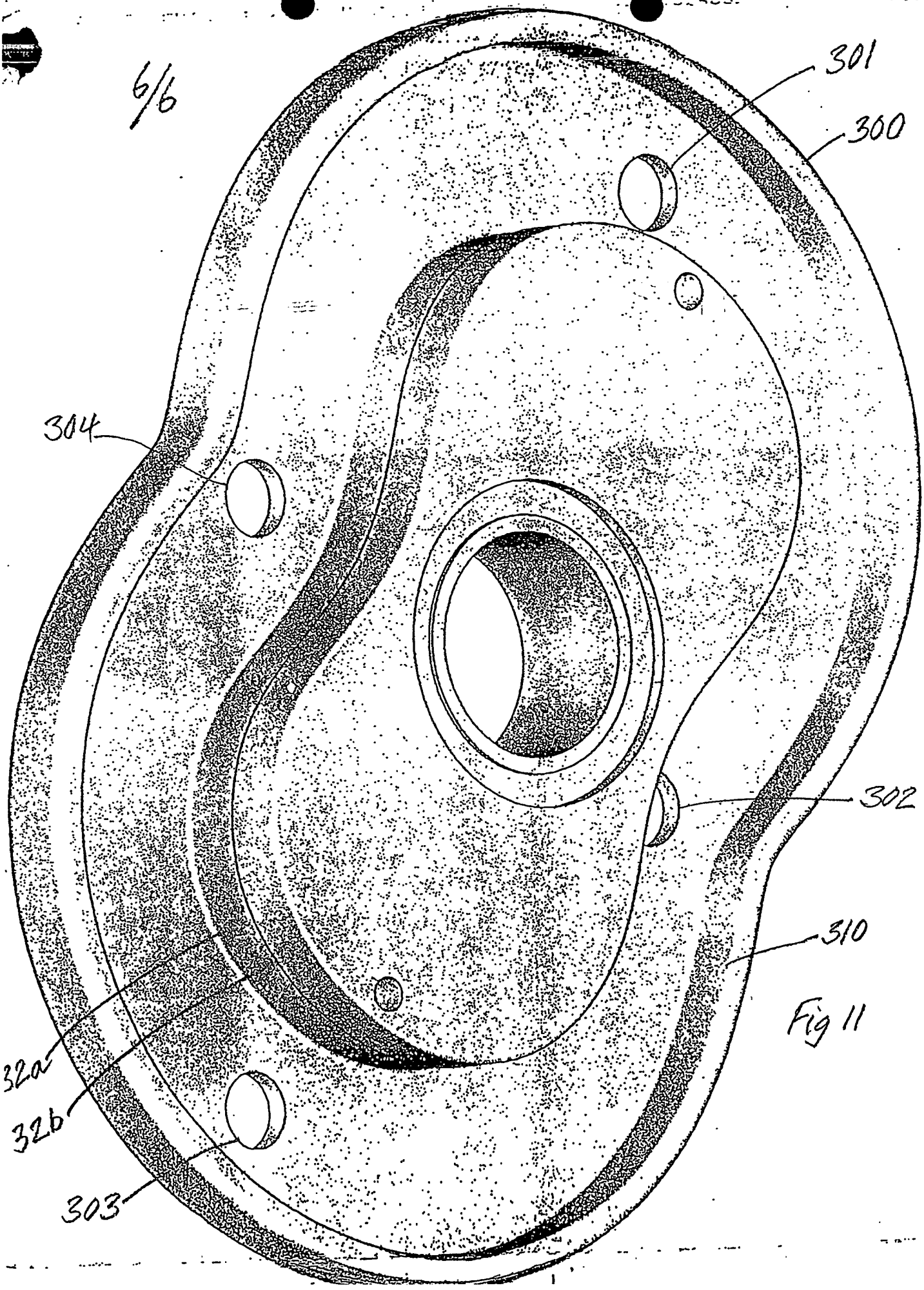

Fig 11

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☑ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☑ FADED TEXT OR DRAWING
- ☑ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☑ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☑ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.
As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.